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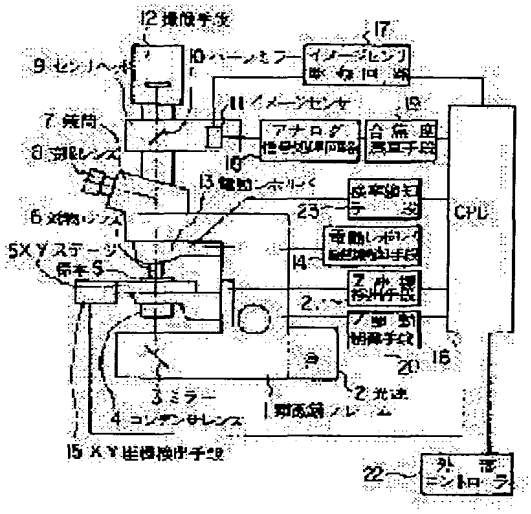
(54) AUTOMATIC FOCUS MATCHING DEVICE OF MICROSCOPE

(57)Abstract:
PROBLEM TO BE SOLVED: To perform the speedy and accurate focusing by moving a stage or objective lens along the optical axis according to a set focusing degree arithmetic range and putting the lens in focus on a sample.
SOLUTION: When an external controller 22 sends the command for the start of the focusing operation, a CPU 16 sets the focusing degree arithmetic range for the XY coordinates by referring to the XY coordinates of the XY stage 5 detected by an XY coordinate detecting means 15. Then the electric signal from an image sensor 11 is passed through an analog signal processing circuit 18 and converted by a focusing degree arithmetic means 19 into a focusing degree evaluated value to drive the XY stage 5 for a specific time by a specific quantity along the optical axis of the objective lens 6. When the focusing degree evaluated value that the focusing degree arithmetic means 19 inputs to the CPU 16 reaches a specific value, the driving of the XY stage 5 is stopped at this focusing position with a command from the CPU 16 and the focusing completion is displayed at a display part provided to the external controller 22.



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CLAIMS

[Claim(s)]
[Claim 1] evaluation values characterized by providing the following, such as contrast, — the degree of focus of a sample image — calculating — the optical axis of an objective lens — receiving — abbreviation — the automatic-focusing adjustment equipment of the microscope which focuses to a sample by moving the X-Y stage or objective lens which can be scanned within a perpendicular flat surface in the direction of an optical axis A X-Y coordinate detection means to detect the X-Y coordinate which shows the position to the optical axis of the aforementioned X-Y stage. A degree operation entry means of focus to set up the degree computing range of focus of a sample image to two or more specific ranges of the aforementioned X-Y stage among the movable ranges of the direction of an optical axis of the aforementioned X-Y stage or the aforementioned objective lens. A focus means to make move the aforementioned X-Y stage or an objective lens in the direction of an optical axis, and to focus to the aforementioned sample based on the degree computing range of focus set up by the aforementioned degree operation entry means of focus corresponding to the X-Y coordinate detected with the aforementioned X-Y coordinate detection means.
[Claim 2] Automatic-focusing adjustment equipment of the microscope according to claim 1 characterized by to add a degree computing-range conversion means of focus to change two or more degree computing ranges of focus set up with the aforementioned degree operation entry means of focus into the degree computing range of focus which suits the aforementioned magnification of objective, based on the magnification of objective detected by scale-factor detection means to detect the aforementioned magnification of objective, and the aforementioned scale-factor detection means.
[Claim 3] A z-coordinate detection means to detect the z-coordinate which shows the relative position of the direction of an optical axis of the X-Y stage at the time of a focus being performed by the aforementioned focus means, and an objective lens, A storage means to memorize serially the X-Y coordinate detected by the z-coordinate detected by the aforementioned z-coordinate detection means, and the X-Y coordinate detection means at this time, A prediction focus position calculation means to compute the prediction focus position corresponding to each specific range based on the X-Y coordinate and z-coordinate corresponding to the specific range memorized by the aforementioned storage means at every focus operation, It is based on the prediction focus position computed by the aforementioned prediction focus position calculation means. Newly compute the degree computing range of focus, and it replaces with the degree computing range of focus set up by the aforementioned degree operation entry means of focus at every focus operation. Automatic-focusing adjustment equipment of the microscope according to claim 1 characterized by adding a degree computing-range reconfiguration means of focus to set up the newly computed degree computing range of focus.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the automatic-focusing adjustment equipment of the microscope which performs focus doubling in the sample of a microscope stage automatically.
[0002]
[Description of the Prior Art] When observing a sample under a microscope, since the range of visible-ray shaft orientations is narrow, generally a picture shallowly the depth of focus of an objective lens with the automatic-focusing adjustment equipment for microscopes A stage or an objective lens is moved in the direction of an optical axis as the 1st step, and the position where a certain amount of contrast is acquired is looked for. after that as the 2nd step Control of moving a stage or an objective lens to a focus position is performed calculating the degree evaluation values of focus, such as contrast.
[0003] For example, according to JP,64-54408,A, the position which becomes more than the threshold to which it was beforehand set as limitation, and that detected the contrast in each position and contrast defined beforehand while making it move fixed distance every in the number of times of predetermined about an installation base (stage) is searched.
[0004] And it moves fixed distance every and the automatic-focusing adjustment method of asking for three continuous positions where the contrast in the mid-position serves as the maximum, and performing alignment by making into a focal position the position obtained according to a weighted average operation using the value of the contrast of each position in the range which defined the installation base beforehand based on this search result and from which contrast becomes more than the above-mentioned threshold is indicated.
[0005] However, in the conventional technology shown in JP,64-54408,A, since a contrast operation is always performed at a fixed interval even if a sample separates greatly from the depth of focus range of an objective lens and the picture is not in sight, as a result of requiring time by picture detection, focus time will become long.
[0006] Since the storage time of the image sensors for calculating the contrast of an image must be especially lengthened when a picture is dark, it has the fault that focus time becomes still longer.
[0007] As what cancels such a fault, in a Japanese-Patent-Application-No. No. 111178 [six to] official report The sample image formed with an objective lens is projected on CCD series. In the microscope automatic-focusing detection equipment which performs focus control by adjusting the relative distance of a sample and an objective lens, calculating the acquired electrical signal according to a predetermined performance index, and detecting punctate based on this result of an operation The performance index for detecting punctate is made into the function which shows the luminosity of an image as the 1st step. It switches to the function which shows the degrees of focus, such as contrast of an image, at the 2nd step, and the microscope automatic-focusing method of detection which adjusted the relative distance of a sample and an objective lens so that the degree of focus might become a predetermined value is indicated.
[0008] As opposed to the fixed interval having always performed the contrast operation in above-mentioned JP,64-54408,A, even if the picture was not in sight in a Japanese-Patent-Application-No. No. 111178 [six to] official report Paying attention to correspondence with the luminosity of a picture, and the degree of focus, the performance index which shows the luminosity of a picture before a picture is in sight detects punctate. Since a performance index is switched to the function which shows the degrees of focus, such as contrast of an image, and it detects punctate after adjusting to the position where the luminosity of a picture serves as the maximum and detecting a picture, it is possible for time until it detects a picture to be shortened, consequently to short-**** focus time.
[0009] If compared with the operation of the degrees of focus, such as contrast of a picture, the operation of the luminosity of a picture is simple, also in the operation time, since control is performed so that the luminosity of a picture may serve as the maximum while a short paddle adjusts the relative distance of an objective lens and a stage, it cannot enlarge traverse speed of an objective lens or a stage extremely, but there is a limit also in shortening of the time to picture detection.
[0010] There is automatic-focusing equipment shown in JP,5-16566,B as what limited the sample other than a **** to the slide glass sample. According to JP,5-16566,B, from the focus position of an objective lens Slide glass **, When only an amount including the variation in the precision of the stage containing cover glass ** and these etc. sets up the criteria position of a stage caudad and has a stage caudad rather than a criteria position First, since the degree operations of focus, such as contrast of a picture, were started after moving to a criteria position on a stage, the degree operation of focus is performed in the portion a picture is not in sight to a slide

glass sample, and quick focus doubling is possible.
[0011] However, since it cannot respond to samples other than a slide glass sample, for example, the metal sample which is thick from slide glass, it has the fault that versatility is missing.
[0012] Moreover, usually the small field where samples differ is observed one by one, scanning [when all the fields of the observation part made into the purpose when observing a sample under a microscope are observable at once, it is few, and] an X-Y stage.
[0013] In the three above-mentioned conventional examples, although it aims at performing focus control about a part with a sample quickly and correctly, the automatic-focusing adjustment in the case of observing the small field where samples differ while scanning an X-Y stage in this way one by one is not described.
[0014] The automatic-focusing control method for the focus gap by change of the relative distance between the objective lens produced by the scan of an X-Y stage and a stage is indicated by JP,63-167313,A.
[0015] The objective lens driving gear which drives the objective lens of a microscope in the vertical direction according to this official report, In the thing equipped with the stage driving gear which drives a stage horizontally, and the automatic-focusing equipment which outputs a focal signal using the electrical signal acquired by carrying out photo electric translation of the microscope picture Before carrying out observation and measurement using a microscope, in quest of the focusing point position in the arbitrary lattice points of a stage, it memorizes beforehand. The focusing point position of point of measurement is interpolated from the focusing point position of near memorized at the time of actual measurement, and after making the focusing [approximation] point position which asked for the objective lens carry out high-speed movement, it is made to perform automatic focusing.
[0016] By memorizing the focusing point position in the arbitrary lattice points of a stage in this example, before performing observation of a sample and measurement, at the time of actual measurement It is an effective method when observing the field where samples differ one by one, scanning a stage horizontally since it is possible for the focusing [approximation] point position in point of measurement to be called for from the lattice point near the point of measurement, and to perform automatic-focusing processing near the true focusing point position of point of measurement.
[0017]
[Problem(s) to be Solved by the Invention] In the conventional example shown in JP,63-167313,A, observation and initial operation of memorizing in quest of the focusing point position in the arbitrary lattice points of a stage beforehand before measurement are performed.
[0018] In the case of this initial operation, since it does not exist, and the focus control in one point of a sample needs to take time upwards and only the number of the lattice points needs to perform this operation, the focusing point position data which should be referred to require most time for the whole initial operation.
[0019] Moreover, although it is satisfactory if there is no variation in the thickness of a sample when exchanging a different sample one by one and performing observation and measurement, such a thing has the fault that initial operation must be performed whenever there is almost nothing in fact and it exchanges samples.
[0020] Furthermore, it may be earlier for processing for the flatness of a sample to have been bad, for starting automatic-focusing operation to necessarily have not restricted that it was the optimal, after moving an objective lens to a focusing [approximation] point position, when there is a wave, but to start automatic-focusing operation from the last focusing point position.
[0021] While this invention was made in view of the above-mentioned actual condition and scans a microscope stage, when observing the part from which a sample differs one by one, even if there is variation in the mechanical precision of a stage, the thickness of a sample, flatness, etc., it is in offering the automatic-focusing adjustment equipment of the microscope which can perform quick and exact focus doubling.
[0022]
[Means for Solving the Problem] Therefore, invention which relates to a claim 1 first in order to attain the above-mentioned purpose evaluation values, such as contrast, -- the degree of focus of a sample image -- calculating -- the optical axis of an objective lens -- receiving -- abbreviation -- by moving the X-Y stage or objective lens which can be scanned within a perpendicular flat surface in the direction of an optical axis A X-Y coordinate detection means to detect the X-Y coordinate which shows the position to the optical axis of the aforementioned X-Y stage in the automatic-focusing adjustment equipment of the microscope which focuses to a sample, A degree operation entry means of focus to set up the degree computing range of focus of a sample image to two or more specific ranges of the aforementioned X-Y stage among the movable ranges of the direction of an optical axis of the aforementioned X-Y stage or the aforementioned objective lens, It is based on the degree computing range of focus set up by the aforementioned degree operation entry means of focus corresponding to the X-Y coordinate detected with the aforementioned X-Y coordinate detection means. It is characterized by providing a focus means to make move the aforementioned X-Y stage or an objective lens in the direction of an optical axis, and to focus to the aforementioned sample.
[0023] Moreover, invention concerning a claim 2 carries out having added a degree computing-range conversion means of focus change two or more degree computing ranges of focus set up with the aforementioned degree operation entry means of focus into the degree computing range of focus which suits the aforementioned magnification of objective, based on the magnification of objective detected by scale-factor detection means detect the aforementioned magnification of objective, and the aforementioned scale-factor detection means as the feature in the automatic-focusing adjustment equipment of a microscope according to claim 1.
[0024] Furthermore, invention concerning a claim 3 is set to the automatic-focusing adjustment equipment of a microscope according to claim 1. A z-coordinate detection means to detect the z-coordinate which shows the

relative position of the direction of an optical axis of the X-Y stage at the time of a focus being performed by the aforementioned focus means, and an objective lens, A storage means to memorize serially the X-Y coordinate detected by the z-coordinate detected by the aforementioned z-coordinate detection means, and the X-Y coordinate detection means at this time, A prediction focus position calculation means to compute the prediction focus position corresponding to each specific range based on the X-Y coordinate and z-coordinate corresponding to the specific range memorized by the aforementioned storage means at every focus operation, It is based on the prediction focus position computed by the aforementioned prediction focus position calculation means. The degree computing range of focus is newly computed, and it replaces with the degree computing range of focus set up by the aforementioned degree operation entry means of focus at every focus operation, and is characterized by adding a degree computing-range reconfiguration means of focus to set up the newly computed degree computing range of focus.

[0025] Invention concerning a claim 1 sets up the degree computing range of focus of a sample image to two or more specific ranges of an X-Y stage by the degree operation entry means of focus among the movable ranges of an X-Y stage or the direction of an optical axis of an objective lens. by the focus means Since an X-Y stage or an objective lens is moved in the direction of an optical axis and it focuses to a sample based on the degree computing range of focus set up by the degree operation entry means of focus corresponding to the X-Y coordinate detected with the X-Y coordinate detection means Even if the thickness of a sample has change or the precision of an X-Y stage worsens, the degree computing range of focus can be made small, and the time which focus operation takes can be shortened remarkably.

[0026] Since invention concerning a claim 2 changes two or more degree computing ranges of focus set up with the degree operation entry means of focus by the degree computing-range conversion means of focus based on the magnification of objective detected by the scale-factor detection means into the degree computing range of focus which suits the magnification of objective, it can shorten further the time which the degree computing range of focus is reduced according to the magnification of objective, consequently focus operation takes.

[0027] Invention concerning a claim 3 is based on the X-Y coordinate and z-coordinate corresponding to the specific range memorized by the storage means by the prediction focus position calculation means. The prediction focus position corresponding to each specific range is computed at every focus operation. by the degree computing-range reconfiguration means of focus Based on the prediction focus position computed by the prediction focus position calculation means, the degree computing range of focus is newly computed. Since the degree computing range of focus which replaced with the degree computing range of focus set up by the aforementioned degree operation entry means of focus at every focus operation, and was newly computed is set up according to the thickness of a sample, or the precision of a stage, the always optimal degree computing range of focus is set up automatically, and always quick -- and -- right -- **** focus operation is realizable

[0028]

[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is explained with reference to a drawing.

<Gestalt of the 1st operation> drawing 1 is drawing showing the composition of the microscope concerning the gestalt of operation of the 1st of this invention. In this drawing, the light from the light source 2 attached in the tooth-back lower part of the microscope frame (it only abbreviates to a frame below) 1 is reflected up by the mirror 3. And the reflected light reflected by this mirror 3 passes a condensing lens 4, and is irradiated by the sample S on X-Y stage 5.

[0029] And after the light which penetrated Sample S and was diffracted is condensed with an objective lens 6, it is carried out for 2 minutes by the division prism which is not illustrated in the lens-barrel 7 attached in the anterior upper part of a frame 1. One side is led to an ocular 8 among this halved light, and another side passes a lens-barrel 7 as it is, and is led to the sensor head 9 attached in the upper part of a lens-barrel 7.

[0030] In this sensor head 9, the one-way mirror 10 which carries out the flux of light from an objective lens 6 for 2 minutes is formed, the flux of light reflected by the mirror 10 is led to the image sensors 11 for the degree detection of focus, and the flux of light which passed the mirror 10 is led to the image pck-up means 12 attached in the upper part of the sensor head 9.

[0031] In addition, to an optical path, it can evacuate and the one-way mirror 10 in the division prism which is not illustrated and the sensor head 9 in a lens-barrel 7 can be inserted independently, respectively. Moreover, you may be the composition which can carry out insertion evacuation of the total reflection prism which reflects all the flux of lights instead of and a total reflection mirror to an optical path. [division prism or a one-way mirror 10]

[0032] The objective lens 6 is attached in the electric revolver 13, and an electric change is possible to two or more objective lenses with which the scale factors which are not illustrated by the electric revolver drive control means 14 differ.

[0033] XY coordinate which 15 is a XY coordinate detection means to detect XY coordinate showing the position of X-Y stage 5 to the optical axis of an objective lens 6, and was detected here is inputted into CPU16. On the other hand, 17 is an image-sensors drive circuit which outputs a driving pulse to image sensors 11 to proper timing by control from CPU16.

[0034] Image sensors 11 change the picture which received light to the timing according to the inputted driving pulse into an electrical signal. 18 is an analog signal processing circuit for performing predetermined processing to this electrical signal, and sends the signal after processing to the degree operation means 19 of focus for detecting the degree of focus of samples, such as contrast.

[0035] With the degree operation means 19 of focus, the degree of focus calculates according to predetermined

operation expression, and the result is sent to CPU16. Moreover, 20 is Z drive control means for driving X-Y stage 5 to a Z direction along with the optical axis of an objective lens 6, and doubling a focus with Sample S, and a focus is united with Sample S by driving the amount of specification at a suitable speed by instructions of CPU16.
[0036] 21 is a Z coordinate detection means to detect the direction position of an optical axis of X-Y stage 5. 22 is an external controller for inputting directions of a focus operation start, and other setup.
[0037] The degree operation entry means of focus for setting up the degree computing range of focus of the degree operation means 19 of focus, and making CPU16 memorize and the power focus directions means for a manual performing focus doubling are also included in this external controller 21.
[0038] The scale-factor data which 23 is a scale-factor detection means to detect the scale factor of an objective lens 6, and are detected are inputted into CPU16. Furthermore, X-Y stage 5 is explained with reference to drawing 2 . Drawing 2 is drawing which saw X-Y stage 5 from the optical-axis upper part of an objective lens 6.
[0039] An upper stage freely movable in the direction of Y and 32 hold a slide glass sample to the lower stage which 31 does not illustrate in this drawing, it is the crane mel which can move in the direction of X freely on the upper stage 31, and they are two slide glass samples S1. And S2 It can hold now.
[0040] 33 is an operation handle. The handle for X directional movements (X handle is only called below), The handle for Y directional movements (Y handle is only called below) is constituted by the same axle. Since it moves in the direction of Y to the lower stage which the upper stage 31 does not illustrate by rotating Y handle and the crane mel 32 moves in the direction of X to the upper stage 31 by rotating X handle Sample S1 And S2 It moves in the XY direction to the optical-axis position 0, and is a sample S1. And S2 It has come to be able to carry out alignment in the XY direction free to the optical-axis position 0.
[0041] And the X coordinate detection means attached in the upper stage 31 for 34 to detect the direction position of X of the crane mel 32 to the upper stage 31 and 35 are the Y coordinate detection meanses attached in the lower stage to detect the direction position of Y of the upper stage 31 to the lower stage which is not illustrated.
[0042] Sample [as opposed to the optical-axis position 0 by the detection result of these X coordinate detection means 34 and the Y coordinate detection means 35] S1 since the lower stage which is not illustrated is attached in the position to the optical-axis position 0 consequently And S2 The XY direction position will be recognized. In addition, these X and a Y coordinate detection means can consist of well-known linear encoders etc., respectively.
[0043] Next, operation of the constituted microscope is explained with reference to the flow chart shown in drawing 3 like ****. The external controller 22 performs initial setting for performing focus operation first in the following procedures. With the directions from the power focus directions means included in the external controller 22, a Z direction is made to carry out the manual drive of X-Y stage 5, the operation handle 33 of X-Y stage 5 is operated, and it is a sample S1. By making it move to the optical-axis position 0, it is a sample S1. Focus doubling of this abbreviation is performed (step1).
[0044] And sample S1 The starting point YS1 of the Y coordinate corresponding to the range and a terminal point YE1, and the computing range deltaZalpha of the degree operation means [in / this Y coordinate range / further] 19 of focus are inputted by the input means of the external controller 22.
[0045] Similarly, the operation handle 33 is operated and it is a sample S2. Focus doubling of this abbreviation is performed and it is a sample S2. The computing range deltaZbeta of the degree operation means 19 of focus is inputted into the starting point YS2 of a Y coordinate and the terminal point TE2 pan corresponding to the range. By this operation, it is a sample S1. The degree computing range of focus in the corresponding Y coordinate range is a minimum position. ZL1=Zc1-deltaZalpha -- (1)
Upper limit position ZH1=Zc1+deltaZalpha -- (2)
(However, Zc1 this abbreviation focus position of a sample S1)
Sample S2 The degree computing range of focus in the corresponding Y coordinate range is a minimum position. ZL2=Zc2-deltaZbeta -- (3)
Upper limit position ZH2=Zc2+deltaZbeta -- (4)
(However, Zc2 this abbreviation focus position of a sample S2)
It can set up (step2). The relation of these coordinates is shown in drawing 4 .
[0046] Next, actual focus operation is explained. First, a stage is moved to an observation part (step3). By the external controller 22, if instructions of a focus operation start are emitted (step4), with reference to XY coordinate of X-Y stage 5 detected with XY coordinate detection means 15 (step5), CPU16 will set up the degree computing range of focus to the XY coordinate (step6).
[0047] Here, according to a Y coordinate, the minimum position of the degree computing range of focus is set as ZL1 or ZL2. And when the Z coordinate detected with the Z coordinate detection means 21 (step7) is the minimum position ZL1 of the degree computing range of these focuses, or below ZL2 (an objective lens 6 and the direction to leave are called bottom), CPU16 takes out instructions to Z drive control means 20, and X-Y stage 5 is driven to a Z direction to the above-mentioned minimum position ZL1 or ZL2 (step8, step9).
[0048] If X-Y stage 5 reaches the above-mentioned minimum position ZL1 or ZL2, it will go into the mode which repeats this by control of CPU16 by making the degree operation of focus (step10), and Z drive of the specified quantity into 1 cycle.
[0049] The Z direction drive of X-Y stage 5 in this mode is explained with reference to drawing 5 . Time deltats corresponding to the storage time of image sensors 11 with this mode The ** which does not drive between X-

Y stage 5 in the direction of an optical axis of an objective lens 6, The step which changes the electrical signal from image sensors 11 into the degree evaluation value of focus with the degree operation means 19 of focus via the analog signal processing circuit 18, time deltatz between X-Y stage 5 -- the direction of an optical axis of an objective lens 6 -- deltaZ1 only -- as the step to drive is shown in drawing 5 , it is repeated stair-like
[0050] And if the degree evaluation value of focus inputted into CPU16 turns into a predetermined value from the degree operation means 19 of focus, the drive of X-Y stage 5 is this focus position Zf by the instructions from CPU16. While being stopped (step11, step12), the display of the completion of a focus is performed to the display prepared in the external controller 22 (step13).
[0051] Moreover, predetermined time tL Even if it performs focus operation in the mode of the between above, when the degree evaluation value of focus does not turn into a predetermined value, while the drive of X-Y stage 5 is stopped by the instructions from CPU16 (step15, step16), a non-focusing display is performed to the display of the external controller 22 (step17).
[0052] Moreover, time tL Even if it is less than, while the degree evaluation value of focus has not turned into a predetermined value, when the Z coordinate of X-Y stage 5 reaches the upper limit ZH1 of the degree computing range of focus set up first, or ZH2 (step18, step19), the drive of X-Y stage 5 is stopped by the instructions from CPU16 (step16), and a non-focusing display is performed to the display of the external controller 22 (step17).
[0053] Since the computing range of a focusing point can be appropriately made small even when two different slide glass samples on X-Y stage 5 are carried and observed by XY coordinate of X-Y stage 5 in the form of this operation as mentioned above and variation is in the focus position of a sample, since it was made to carry out adjustable [of the computing range of the degree operation means 19 of focus], focus doubling can carry out quickly and correctly.
[0054] In addition, in above-mentioned explanation, although the degree computing range of focus was changed only by the Y coordinate as shown in drawing 4 , of course, it is changeable with an X coordinate.
[0055] Moreover, although the case where an X-Y stage was moved was explained, you may make it double a focus by moving an objective lens in explanation of the form of this operation.
[0056] Although the input method of the degree computing range of focus also adopted the method of directing the starting point and the terminal point of a coordinate, it is not what was restricted to this method. Moreover, in the form of this operation, although XY drive operation of X-Y stage 5 was made into the manual operation by the operation handle 33, naturally you may be the thing of the type which carries out an electric drive using an actuator.
The microscope concerning <the form of the 2nd operation>, next the form of operation of the 2nd of this invention is explained.
[0057] In the form of this operation, the computing range of the degree operation means 19 of focus is made adjustable according to the magnification-of-objective data detected by the scale-factor detection means 23. For example, when an observer inputted the degree computing range deltaZalpha of focus on the basis of the case where an objective lens 6 is a high scale factor like 40 times to 100 times, the computing range was described in the form of the 1st operation of the above-mentioned. ZL1=Zc1-deltaZalpha <= Z <= ZH1=Zc1+deltaZalpha -- (5)
Although it became, when an objective lens 6 is switched to the thing of a low scale factor, it is deltaZalpha'= k-deltaZalpha about the degree computing range of focus in a low scale factor by CPU16. -- (6)
It is determined as (the constant to which k is proportional to the depth of focus of an objective lens), and is a computing range automatically. ZL1'=Zc1-deltaZalpha'<=Z<= ZH1=Zc1+deltaZalpha' -- (7)
It sets up.
[0058] Drawing 6 is drawing showing the relation of the degree computing range of focus before and behind conversion. Therefore, an observer only inputs only the computing range [in / a specific scale factor / it is not necessary to set up the degree computing range of focus for every objective lens, and] from which a scale factor differs, and since he can set up automatically the degree computing range of focus suitable for the objective lens of each scale factor, he has the advantage that simplification of operation can be measured.
[0059] In addition, in the gestalt of this operation, although the degree computing range of focus was divided for the low scale factor and the high scale factor, it is constituting so that a computing range's may be set up for every magnification of objective still more finely, and it cannot be overemphasized that the increase in efficiency of focus operation is still more possible.
Operation of the microscope concerning <the gestalt of the 3rd operation>, next the gestalt of operation of the 3rd of this invention is explained with reference to the flow chart of drawing 7 . A different point from the microscope concerning the gestalt of the 1st operation of a **** and the microscope concerning the gestalt of this operation is in the setting method of the degree computing range of focus of the degree operation means 19 of focus.
[0060] First, sample S1 In order to double the focus of this abbreviation by the suitable part, a Z direction is made to carry out the manual drive of X-Y stage 5 with directions of the power focus directions means prepared in the external controller 22 (step31).
[0061] Next, if it checks that the focus has suited mostly, it is the computing-range central value Zc as an early degree computing range of focus. And a computing range deltaZalpha is inputted by operation of the external controller 22. It is the early degree computing range of focus by this operation. ZL1= Zc-deltaZalpha <= Z <= ZH1=Zc+deltaZalpha -- (8)
It is set up (step32).

[0062] And sample S1 X-Y stage 5 is moved within XY flat surface to double a part to observe on an optical axis o (step33), and instructions of a focus operation start are given by the external controller 22 (step34).
[0063] If instructions of a focus operation start are emitted, CPU16 will judge first whether it is operation this focus operation of whose is what time (step35). Degree computing-range ZL of focus >=Z>=ZH by which initial setting was carried out to the Z coordinate (step39) detected with the Z coordinate detection means 21 when it was the 1st time or the 2nd focus operation It compares, it checks that the present Z coordinate is in degree operation within the limits of focus, and moves to the operation of the degree of focus (step40, step42).
[0064] If the present Z coordinate is outside the degree computing range of focus, it is the computing-range minimum ZL about X-Y stage 5. After driving (step41), the operation of the degree of focus is started. And as the gestalt of the 1st operation and the 2nd operation gestalt were described By carrying out by repeating this by making the degree operation of focus, and Z drive of the specified quantity into 1 cycle, (step 43, 48, 51, and 52), Finally it is a predetermined time tL. When the degree evaluation value of focus turns into a predetermined value by inside and degree operation within the limits of focus, the position stops [X-Y stage 5], and a focus is obtained (step 44 and 45).
[0065] If it is a coordinate at the time of the 1st completion of a focus (x1, y1, and z1), and the 2nd focus operation, the coordinate at the time of the 2nd [further] completion of a focus (x2, y2, and z2) will be memorized in order by the focus coordinate-storage means in CPU16 (step46).
[0066] Generally, when observing a sample under a microscope, one side does not have few cases observed while moving only in the direction of X, or the direction of Y on a stage among X or a Y coordinate with fixation, either.
[0067] the above-mentioned focus coordinate (x1, and y1 and z1) when a Y coordinate is fixed and X-Y stage 5 is being now moved in the direction of X, and (x2, y2 and z2) -- setting -- y1 =y2 it is -- a case is considered
[0068] the case where 3rd focus operation is performed -- XY coordinate (x3 and y3) of the 3rd observation part -- also setting -- y1 =y2 =y3 it is, if it is not extremely big movement in the direction of X Z coordinate Z3 at the time of the completion of a focus in this 3rd observation part It can assume that it exists on the 1st time of last time, the 2nd focus coordinate (x1 and z1), and the straight line that passes along (x2 and z2), and can predict.
[0069] That is, prediction focus position Z3 ' is solving a simultaneous equation. z3 '= {z1-(x3-x2) z2} (x3-x1) / (x1-x2)
-- (9)
It asks.
[0070] Similarly, Nth prediction focus position ZN ' is called for as follows using 2 times of the memorized focus coordinates (xN-1 and zN-1), and (xN-2 and zN-2) just before [the].
zN '={zN-2 (xN-xN-1)
- ZN-1 (XN-XN-2)}/(XN-2-XN-1) -- (10)
Drawing 8 is drawing showing the relation of the focus position and prediction focus position which were memorized.
[0071] moreover, in observing moving X-Y stage 5 also in the direction of X also in the direction of Y General formula ax+by+c=z which expresses the flat surface on 3-dimensional space for 3 times of the memorized focus coordinates (xN-1, yN-1, and zN-1), (xN-2, yN-2 and zN-2), and (xN-3, yN-3 and zN-3) just before -- (11) Prediction focus position zN ' is called for by solving the simultaneous equation substituted [is boiled and] and obtained by the well-known math-processing method. The degree computing range of focus memorized by CPU16 if prediction focus position ZN ' is called for as mentioned above is eliminated, and it is newly the degree computing range of focus. ZLN=ZN '-deltaZalpha <= Z <= ZHN=ZN '+deltaZalpha -- (12)
** -- it sets up like
[0072] And the present Z coordinate is detected, and as compared with degree computing-range ZLN<=Z<=ZHN of focus by which an updating setup was carried out, CPU16 controls by the same step as the 1st time and the 2nd time, and it results in the completion of focus operation.
[0073] Therefore, in the form of this operation, it asks for the focusing [prediction] point position in the following observation part using the focus coordinate data obtained by focus operation at each time. Since the range which calculates the degree of focus based on this focusing [prediction] point position is set up and this was updated at every focus operation The time required by focus, without being able to make the degree computing range of focus small, and performing the useless degree operation of focus even if the thickness of a sample has change or the stage leans can be shortened.
[0074] Moreover, in the form of this operation, although it asked for the prediction focus position as a point on a straight line or a flat surface using 2 times or 3 times of the last focus coordinate data, it is also effective to ask as a point on secondary a curve or a curved surface using 3 times or more of focus coordinate data.
[0075] Furthermore, naturally it is also possible to constitute like the form of the 1st operation as an electric stage which drives an X-Y stage with an actuator. Furthermore, in the form of this operation, although instructions of a focus operation start were inputted whenever it moved the observation part, it is also possible to apply to a continued type focus-control method which repeats focus operation by the suitable time interval, moving an observation part by control of CPU.
[0076]
[Effect of the Invention] A XY coordinate detection means to detect the coordinate of an X-Y stage according to this invention as a full account was given above, Since a degree operation entry means of focus to set up the range which calculates the degree of focus of a sample image is established and it was made to make the

degree computing range of focus adjustable according to XY coordinate detected The thickness of a sample can have change, or even if the precision of an X-Y stage is bad, the degree computing range of focus can be made small, and the time which focus operation takes can be shortened remarkably.
[0077] Moreover, the time which focus operation takes as a result of being able to simplify operation of an observer and reducing the degree computing range of focus further upwards according to the magnification of objective, since a scale-factor detection means to detect the magnification of objective is established and it was made to make the degree computing range of focus adjustable by the magnification of objective can be shortened further.
[0078] Furthermore, a focus coordinate-storage means to memorize serially the coordinate at the time of the completion of focus operation is established. Since it asks for the prediction focus position in the following observation part using at least two focus coordinate data including the last focus coordinate, the degree computing range of focus is set up based on this focusing [prediction] point position and this was updated at every focus operation According to the thickness of a sample, or the precision of a stage, the always optimal degree computing range of focus is set up automatically, and crosses to the wide range field of a sample, and always quick and exact focus operation of it is attained.

[Translation done.]

* NOTICES *

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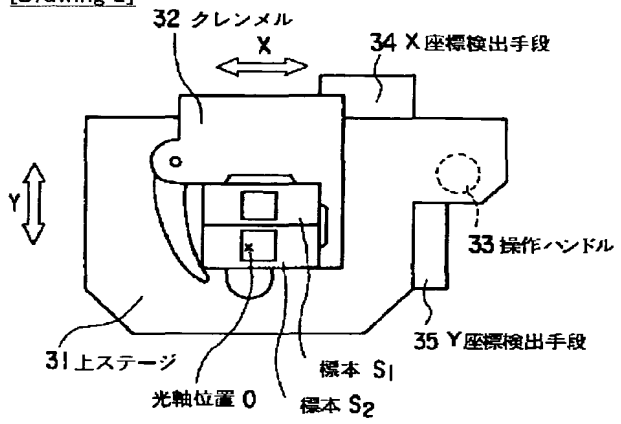
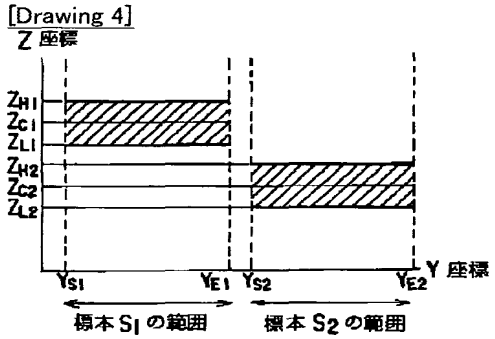
DRAWINGS

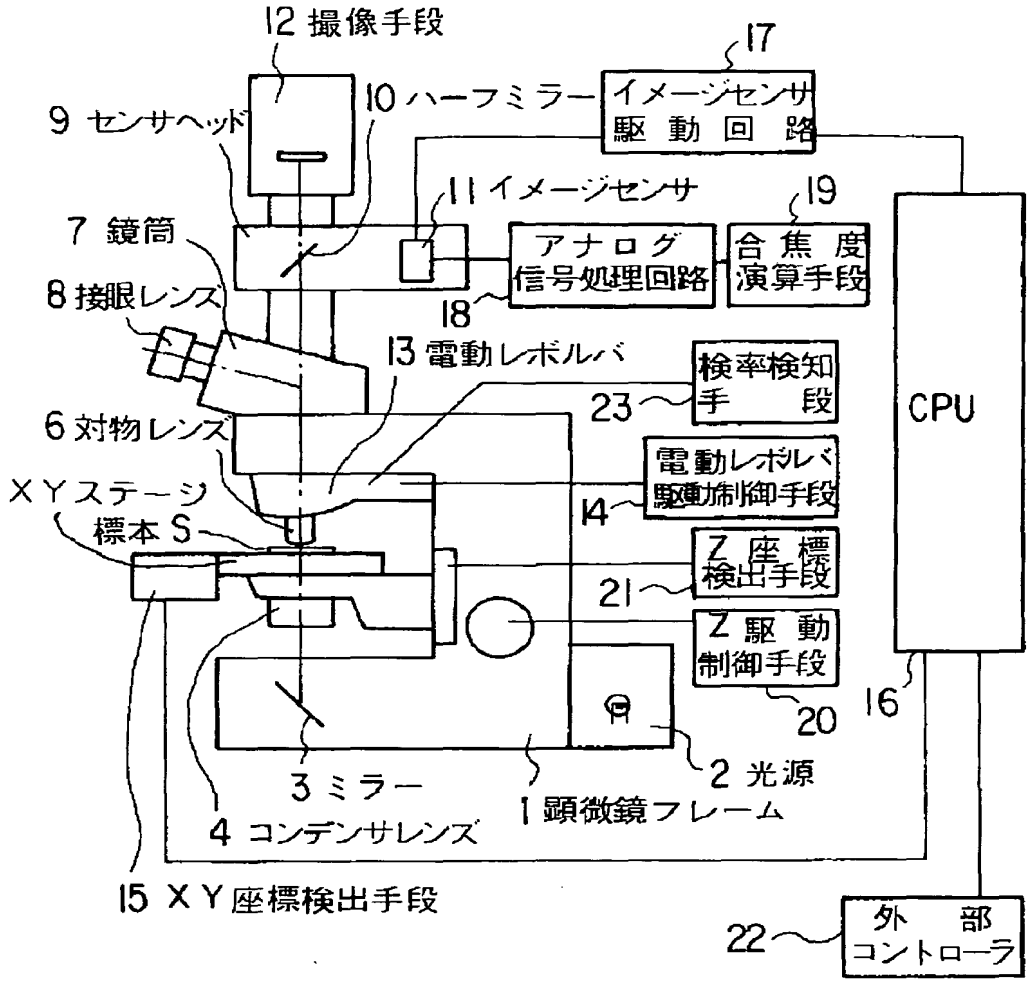
[Drawing 2]



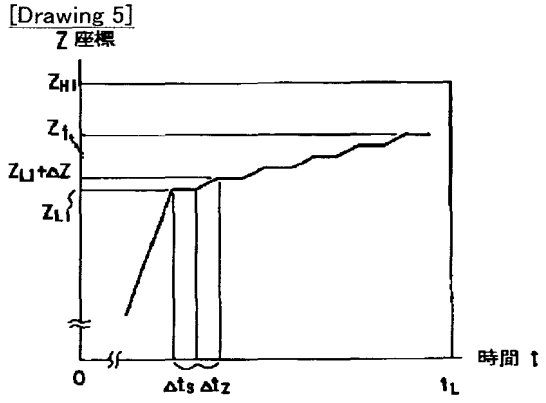
[Drawing 4]



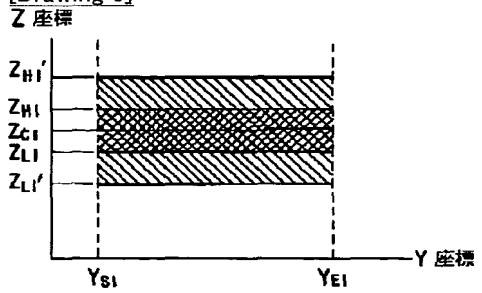
[Drawing 1]



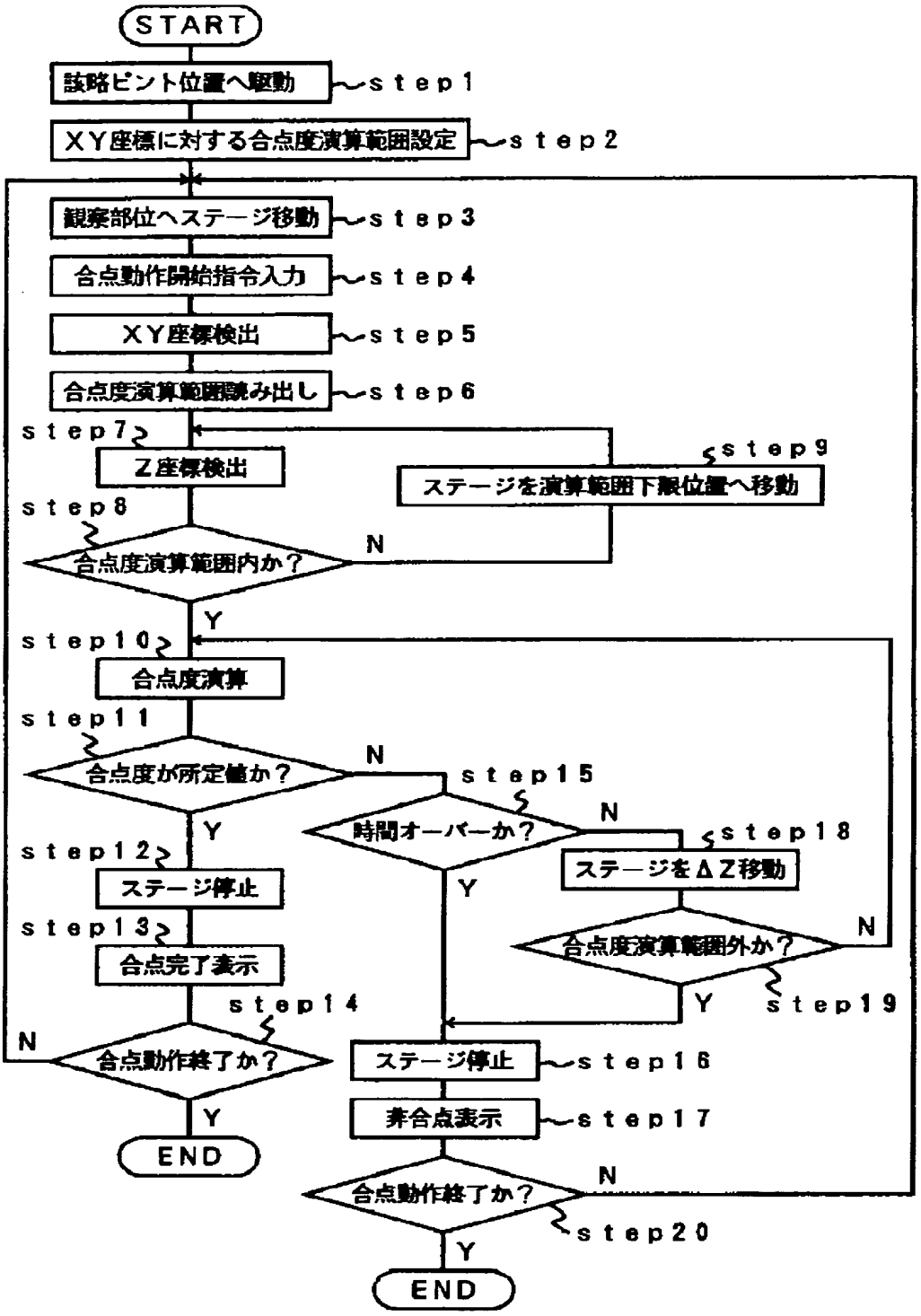
[Drawing 5]



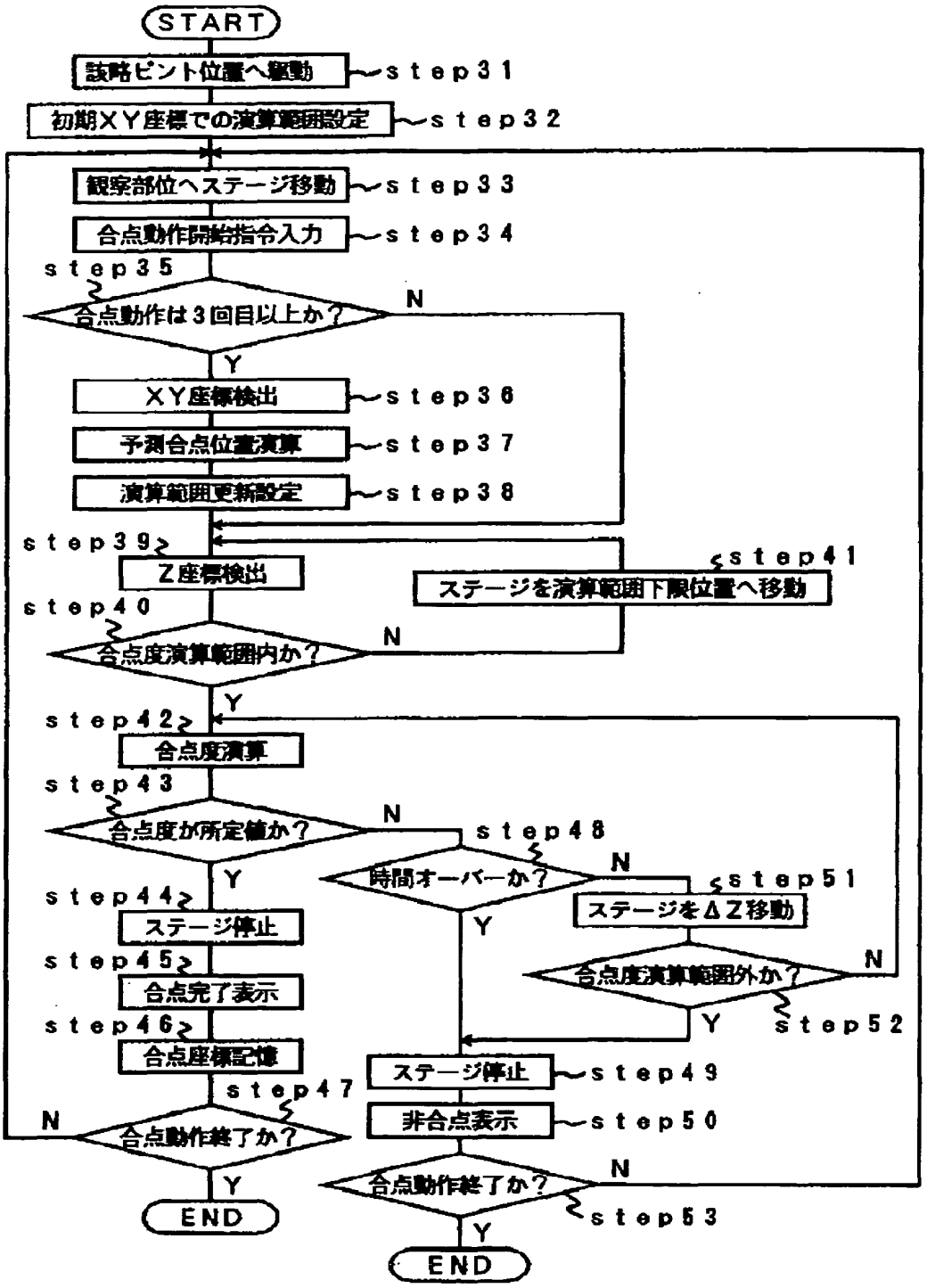
[Drawing 6]



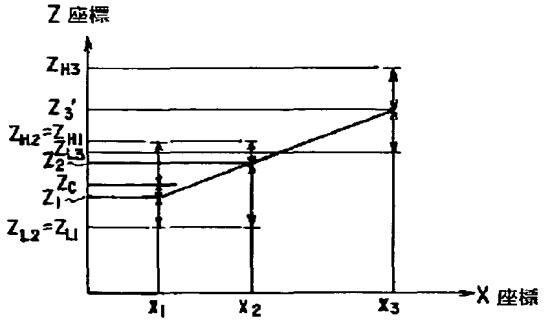
[Drawing 3]


START
該略ピント位置へ駆動
step1
XY座標に対する合点度演算範囲設定
step2
観察部位へステージ移動
step3
合点動作開始指令入力
step4
XY座標検出
step5
合点度演算範囲読み出し
step6
step7
Z座標検出
step9
ステージを演算範囲下限位置へ移動
step8
合点度演算範囲内か？
N
Y
step10
合点度演算
step11
合点度が所定値か？
N
step15
時間オーバーか？
N
step18
ステージをΔZ移動
Y
step12
ステージ停止
step13
合点完了表示
合点度演算範囲外か？
N
Y
step19
step14
N
合点動作終了か？
ステージ停止
step16
Y
非合点表示
step17
END
合点動作終了か？
N
step20
Y
END

[Drawing 7]


START
概略ピント位置へ駆動
step31
初期XY座標での演算範囲設定
step32
観察部位へステージ移動
step33
合点動作開始指令入力
step34
step35
合点動作は3回目以上か？
N
Y
XY座標検出
step36
予測合点位置演算
step37
演算範囲更新設定
step38
step39
Z座標検出
step41
ステージを演算範囲下限位置へ移動
step40
合点度演算範囲内か？
N
Y
step42
合点度演算
step43
合点度が所定値か？
N
step48
時間オーバーか？
N
step51
ステージをΔZ移動
Y
step44
ステージ停止
step45
合点完了表示
step46
合点座標記憶
合点度演算範囲外か？
N
Y
step52
step47
ステージ停止
step49
N
合点動作終了か？
非合点表示
step50
Y
END
合点動作終了か？
N
step53
Y
END

[Drawing 8]


Z 座標
ZH3
Z3'
ZH2=ZH1
ZL3
Z2
Zc
Z1
ZL2=ZL1
X1
X2
X3
X 座標

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the composition of the microscope concerning the gestalt of operation of the 1st of this invention.
[Drawing 2] It is drawing showing the composition of the X-Y stage of the microscope in the gestalt of this 1st operation.
[Drawing 3] It is a flow chart for explaining operation of the microscope in the gestalt of this 1st operation.
[Drawing 4] It is drawing showing the degree computing range of focus of the microscope in the gestalt of this 1st operation.
[Drawing 5] It is drawing for explaining the drive of the X-Y stage of the microscope in the gestalt of this 1st operation.
[Drawing 6] It is drawing showing the relation of the focus computing range before and behind conversion of the microscope concerning the gestalt of operation of the 2nd of this invention.
[Drawing 7] It is a flow chart explaining operation of the microscope concerning the gestalt of operation of the 3rd of this invention.
[Drawing 8] It is drawing showing the relation of the focus position of a microscope and prediction focus position concerning the gestalt of this 3rd operation.
[Description of Notations]
1 [— A mirror, 4 / — Condensing lens,] — A microscope frame, 2 — The light source, 3 5 [— A lens-barrel, 8 / — An ocular, 9 / — Sensor head,] — An X-Y stage, 6 — An objective lens, 7 10 [— An image pck-up means, 13 / — Electric revolver,] — A one-way mirror, 11 — Image sensors, 12 14 [— CPU,] — Electric revolver drive control means, 15 — XY coordinate detection means, 16 17 [— The degree operation means of focus,] — An image-sensors drive circuit, 18 — An analog signal processing circuit, 19 20 [— An external controller, 23 / — A scale-factor detection means, 31 / — A top stage, 32 / — A crane mel, 33 / — An operation handle, 34 / — An X coordinate detection means, 35 / — Y coordinate detection means.] — Z drive control means, 21 — A Z coordinate detection means, 22

[Translation done.]